2011 GROUNDWATER STATUS REPORT

BUTTE COUNTY DEPARTMENT OF
WATER AND RESOURCE CONSERVATION

February 2012

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FOREWORD

This report presents the status of groundwater conditions and land subsidence based on data collected by Butte County and the California Department of Water Resources (DWR) up to and through November 2011. The report gives general information regarding locations of wells and extensometers, statistics related to groundwater level trends, historical precipitation information and hydrographs depicting groundwater levels over time. This report was prepared by the Butte County Department of Water and Resource Conservation (Department) with assistance from DWR, Northern Region and complies with reporting requirements established in Chapter 33 and Chapter 33A of the Butte County Code.

In November 1996, the voters in Butte County approved "AN ORDINANCE TO PROTECT THE GROUNDWATER RESOURCES IN BUTTE COUNTY". One of the stated purposes of the ordinance was that "The groundwater underlying Butte County is a significant water resource which must be reasonably and beneficially used and conserved for the benefit of the overlying land by avoiding extractions which harm the Butte Basin aquifer, causing exceedance of the safe yield or a condition of overdraft." The ordinance is now codified as Chapter 33 of the Butte County Code relating to groundwater conservation. Section 3.01 – "Groundwater Planning Process" requires the preparation of a groundwater status report based upon the data gathered and analyzed pursuant to Section 3.02 – "Groundwater Monitoring".

In 2000, the Butte County Board of Supervisors amended Chapter 33, the Groundwater Conservation Ordinance, to require the Groundwater Status Report (Report) be delivered by February 21st of each year. In 2010, the Water Commission designated the Department of Water and Resource Conservation as the entity responsible for creating and submitting the annual report.

In related activities, in February 2004, the Butte County Board of Supervisors adopted the Groundwater Management Ordinance which was codified as Chapter 33A of the Butte County Code. Chapter 33A calls for the establishment of a monitoring network and Basin Management Objectives (BMOs) to define acceptable groundwater levels, groundwater quality, and land subsidence measurements. The BMO concept was incorporated into California Water Code §10750 et. seq., as a component of AB 3030 Groundwater Management Plans. On September 28, 2004, the Butte County Board of Supervisors formally approved Resolution 04-181 adopting the countywide AB 3030 Groundwater Management Plan (GMP) that includes the components of the BMO program. In 2011 Chapter 33A was amended and retitled to "Basin Management Objectives (BMO)" and now requires that the BMO report be submitted in February of each year. The foregoing actions by the Board allow the reporting of groundwater conditions from Chapter 33 and 33A to be consolidated into a single report to be submitted by the Department on an annual basis each February.

Data from published reports prepared for the Department are included throughout this document where relevant, and the referenced documents are listed in Appendixes, or

as References, as well as being available on the Department website at www.buttecounty.net/waterandresource. All past versions of the Report and BMO documents are also available on the website.

2011 GROUNDWATER STATUS SUMMARY

Hydrologic conditions within Butte County continued to improve in 2011 after four below-normal water years. In 2011 the Sacramento Valley was classified as a wet year. Water years 2007-9 represented the 12th driest three-year period in California's measured hydrologic record. Seven of the last ten years have been below normal. With improved conditions in 2010 and 2011, storage in most major in-state reservoirs rebounded. As of November 1, 2011, the major Central Valley Project (CVP) and State Water Project (SWP) reservoirs all have storage capacities greater than 100 percent of historical average. Storage in SWP's Lake Oroville had increased to 134 percent of average (82 percent capacity).

With improved hydrologic conditions, groundwater levels are also rebounding. The spring 2011 groundwater level measurements showed that of the 102 wells monitored within Butte County, 24 wells still did not meet their BMO and reached an Alert Stage. Wells that reached an Alert Stage were in the Cherokee, Esquon, North Yuba, Chico Urban and Durham/Dayton, Llano Seco, M&T and Vina areas. Most of the wells that reached a BMO Alert Stage had improved groundwater level measurements compared to the spring of 2010. In the fall of 2011, groundwater level data showed that 12 of 79 wells monitored did not achieve their BMO. In comparison, 25 wells reached a BMO Alert Stage in 2010 and 32 wells reached a BMO Alert Stage in 2009. The Durham/Dayton and Chico Urban Areas each reduced the number of wells in Alert Stage to only one well each. While 2011 data looks promising, even with above average precipitation, it typically takes a couple of years to fully recover from a drought period. As the groundwater levels recover from drought conditions, long term trends will continue to be evaluated on a sub-inventory unit basis.

The Department conducted its tenth year of groundwater quality monitoring during the week of July 25 - 29, 2011. As required by Chapter 33, the parameters monitored were temperature, pH and electrical conductivity. These parameters encompass the basic characteristics of evaluating water for evidence of saline intrusion. The groundwater quality monitoring program is designed to track single monitoring events throughout the county during the peak irrigation season on an annual basis. For 2011, all samples fell within the acceptable range of water quality values as set forth by State and federal agencies. Additionally, the results met BMOs for water quality parameters as specified in Chapter 33A.

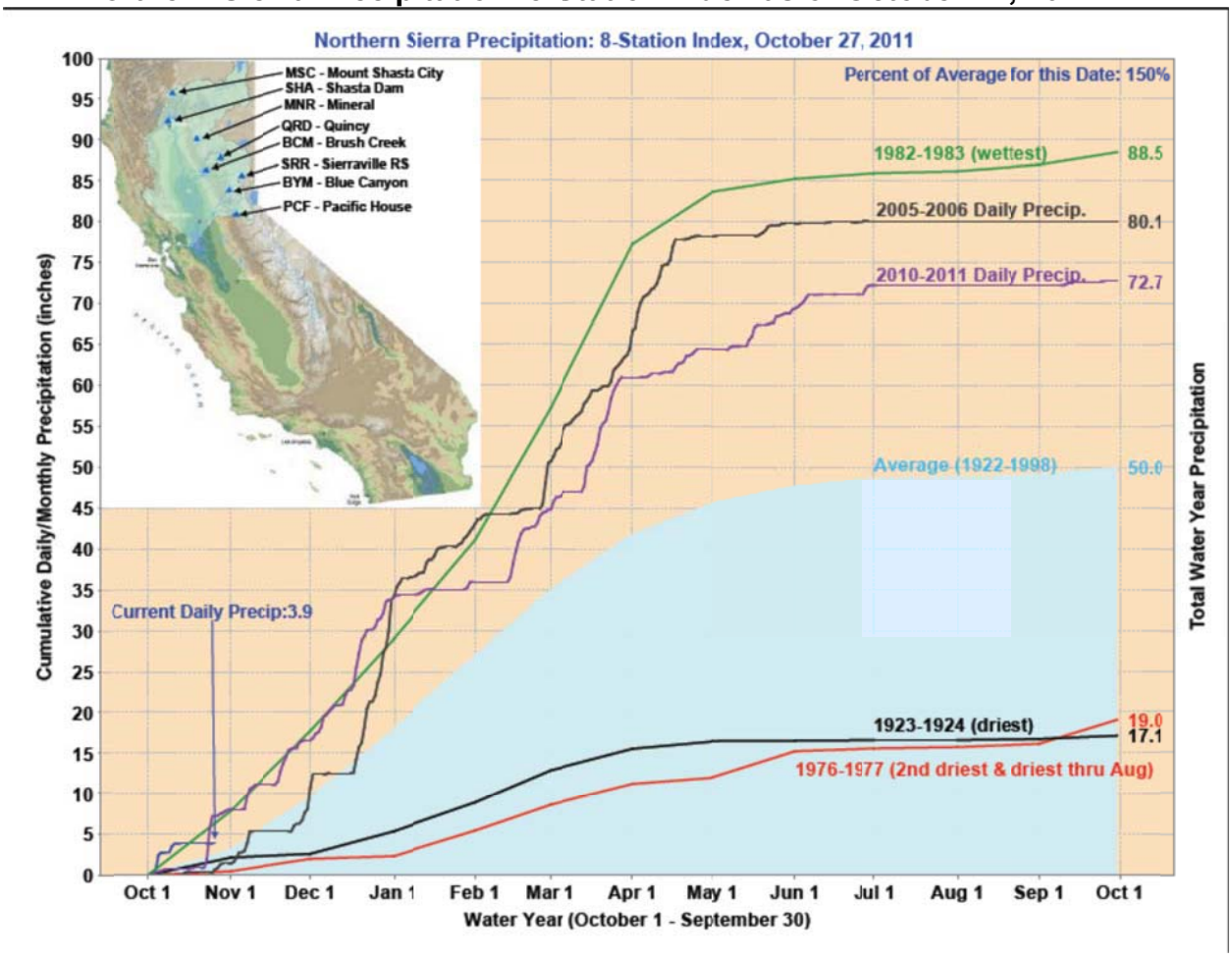
Subsidence is monitored by repeated land surveys and by use of extensometers. These instruments are capable of detecting changes in land surface elevation to approximately 1/100th of an inch. DWR Northern Region has installed and operates seven extensometers in the northern Sacramento Valley: five in Butte County and three in Glenn County. According to the BMO Ordinance, an Alert Stage is reached if the annual elastic subsidence exceeds the average annual elastic subsidence measured over the period of record of the extensometer. No land subsidence was detected in Butte County from an evaluation of the extensometer records in the Western Canal, M&T, Chico Urban Area, Richvale, and Biggs-West Gridley SIUs.

HYDROLOGIC CONDITIONS

There are a number of data sources and indexes available to characterize hydrologic conditions. These data sources typically report hydrologic data on a water year basis, or the 12-month period from October through September. For example, "Water year 2011" means October 1, 2010 through September 30, 2011.

The Northern Sierra 8-Station Precipitation Index serves as a wetness index for the Sacramento River hydrologic region by averaging measurements taken at the following precipitation stations: Blue Canyon, Brush Creek Ranger Station, Mineral, Mount Shasta City, Pacific House, Quincy Ranger Station, Shasta Dam, and Sierraville Ranger Station.[1] This index provides a representative sample of the region's major watersheds: the upper Sacramento, Feather, Yuba, and American rivers, which produce inflow to some of California's largest reservoirs - the source of much of our water supply.

Northern Sierra Precipitation: 8-Station Index as of October 27, 2011



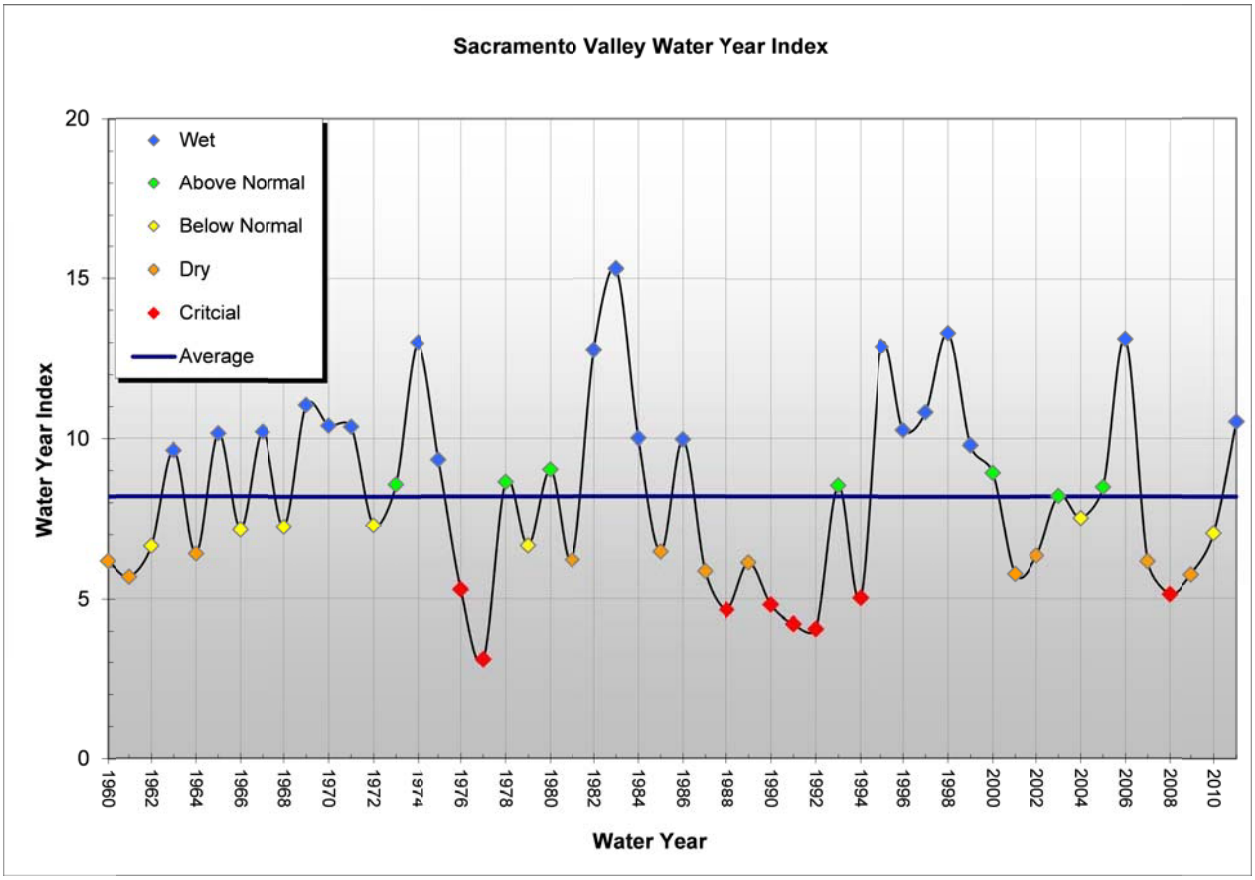
[1] http://cdec.water.ca.gov/cgi-progs/snow/PLOT_ESI

At the end of the 2011 water year on September 30, 2011, *statewide* hydrologic conditions were as follows: precipitation was 135 percent of average to date; runoff was 145 percent of average to date; and reservoir storage, 130 percent of average for the date. Sacramento River Region unimpaired runoff observed through September 30, 2011 was about 25.1 million acre-feet (MAF), which is about 138 percent of average. For comparison, on September 30, 2010, the observed Sacramento River Region unimpaired runoff through that date was about 16.0 MAF, or about 88 percent of average.

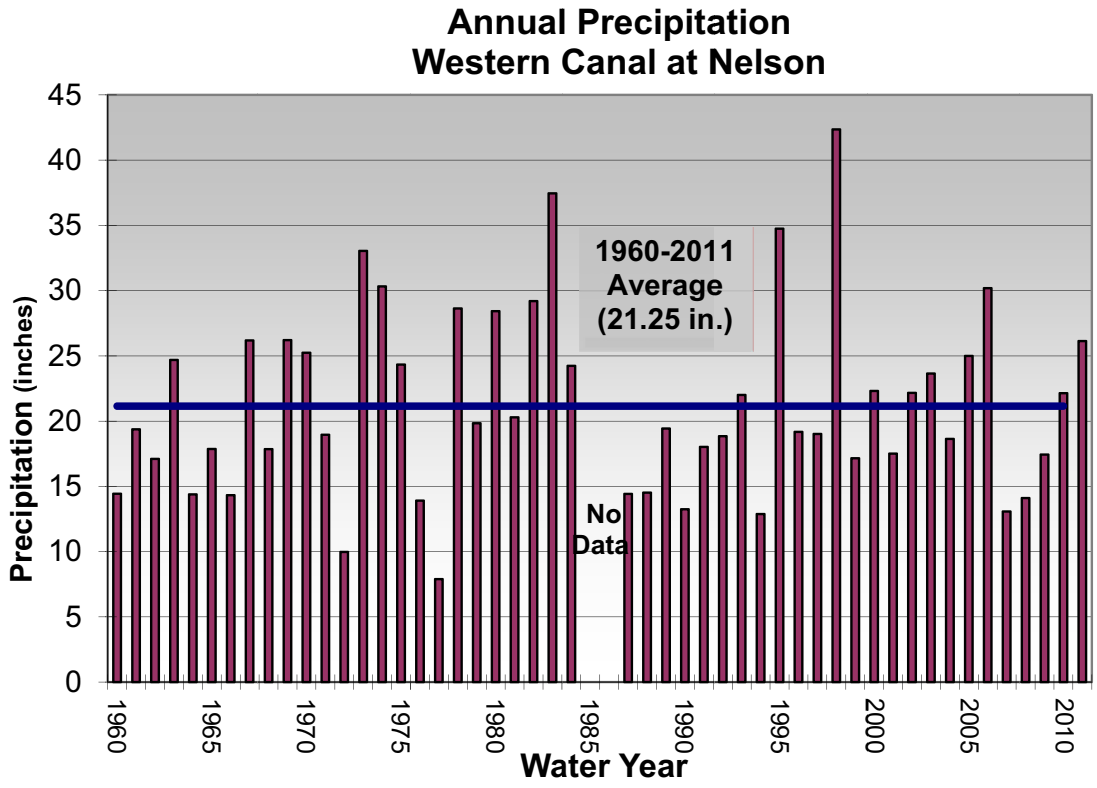
Water year classification systems provide a means to assess the amount of water originating in a basin. Because water year classification systems are useful in water planning and management, they have been developed for several hydrologic basins in California. One of these classification systems, the Sacramento Valley 40-30-30 Index was developed by the State Water Resources Control Board (SWRCB) for the Sacramento hydrologic basins. This system defines one *"wet"* classification, two *"normal"* classifications (above and below normal), and two *"dry"* classifications (dry and critical), for a total of five water year types. The Sacramento Valley 40-30-30 Index is computed as a weighted average of the current water year's April-July unimpaired runoff forecast (40 percent), the current water year's October-March unimpaired runoff forecast (30 percent), and the previous water year's index (30 percent). A cap of 10 MAF is put on the previous year's index to account for required flood control reservoir releases during wet years. Unimpaired runoff (calculated in the 40-30-30 Index as the sum of Sacramento River flow above Bend Bridge near Red Bluff, Feather River inflow to Oroville, Yuba River flow at Smartville, and American River inflow to Folsom) is the river production unaltered by water diversions, storage, exports, or imports. Sacramento Valley Water Year Hydrologic Classification is:

Year Type:	***Water Year Index:***
Wet	Equal to or greater than 9.2
Above Normal	Greater than 7.8, and less than 9.2
Below Normal	Greater than 6.5, and equal to or less than 7.8
Dry	Greater than 5.4, and equal to or less than 6.5
Critical	Equal to or less than 5.4

The Sacramento Valley was classified as a wet year in 2011as shown in the following graphic.


Sacramento Valley Water Year Index
Wet
Above Normal
Below Normal
Dry
Critcial
Average
Water Year Index
Water Year
0
5
10
15
20
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

Precipitation for the water year ending September 30, 2011 at the Western Canal Water District's Climatological Observation Station totaled 26.14 inches, which is almost 5 inches above the 50-year average of 21.15 inches. The figure below represents the total annual precipitation at the Western Canal Station for the 50-year period of water years 1960 through 2011. In the past ten years, half of the water year totals were below the 50 year average. Although there was significantly more precipitation in water year 2011 as compared to the last four years, when reviewing the previous 50-year period, only 21 of those years were above the average precipitation.



SURFACE WATER DELIVERIES

Surface water is an important component to aquifer recharge in the Butte Basin. During the 2011 water year 1,007,683 acre-feet of water was delivered to Western Canal Water District and the Joint Water District Board. The 2011 water year deliveries were almost 5,000 acre-feet more than water year 2010. The demand for surface water deliveries is affected by a number of factors. Although rice acreages were at historic highs in Butte County, late planting, a cool growing season and increased water use efficiency reduced the overall demand. Summarized below are the deliveries in acre-feet to Western Canal Water District and the Joint Water District Board for the water years 1991 to 2011.

Water Year	Western Canal Water District	Joint Water District Board	TOTAL
2000	314,737	707,018	1,032,392
2001	302,784	718,489	1,021,562
2002	305,460	597,529	902,989
2003	271,867	682,403	954,270
2004	329,700	790,663	1,120,363
2005	284,188	750,128	1,034,316
2006	294,898	743,345	1,038,243
2007	318,159	824,286	1,142,445
2008	332,500	740,748	1,073,248
2009	327,184	711,693	1,038,877
2010	313,196	689,518	1,002,714
2011	288,912	718,771	1,007,683

GROUNDWATER CONDITIONS

Monitoring Frequency and Period of Record

The monitoring well grid in Butte County is monitored four times per year as required through Chapters 33 and 33A of the Butte County Code. Sections 33-4 of the Butte County Code enacted in 1996 and 33A-8 of the Butte County Code enacted in 2004 state that groundwater level measurements shall be taken from all designated monitoring wells at least four (4) times per year. Those measurements are to be taken during the months of March, July, August, and October. DWR and the Department split the monitoring duties. DWR takes the spring and fall measurements while the Department takes the July and August measurements. Water quality data are collected annually at the peak of the irrigation season. Monitoring frequency for land subsidence is conducted on a continuous basis through the use of extensometers.

Groundwater Quality Trend Monitoring

The Butte County Groundwater Quality Trend Monitoring Program, in place since 2001, has annually recorded measurements for temperature, pH, and electrical conductivity (EC) on ten wells throughout the county. These three parameters are measured to evaluate for evidence of saline intrusion per Chapter 33. The Groundwater Quality Trend Monitoring Program is not designed to characterize specific groundwater contamination due to pollutants. The data is collected each July/August at the peak of irrigation season to establish baseline levels across the county to detect changes which may require further investigation.

In Butte County, the primary freshwater bearing formations include the Tuscan formations, overlying alluvium deposits, basin deposits, and the Riverbank and Modesto Formations. A number of marine formations beneath the Tuscan formation make up the underlying saline aquifer system.[2] Increasing salinity in groundwater wells could indicate over utilization of groundwater resources. To ensure sustainable management of local groundwater resources, water quality monitoring efforts need to provide baseline trends related to salinity.

The Department conducted its tenth year of groundwater quality trend monitoring within the county during the week of July 25 - 29, 2011 (Appendix D). The 2011 data is comparable to data collected in the nine preceding years. All samples fell within the acceptable range of water quality values as set forth by State and federal agencies. Groundwater quality measurements can trigger a BMO Alert Stage. If the temperature is more than five degrees outside of the historic range of measurements a BMO Alert Stage is reached. If the pH is below 6.5 or above 8.5, a BMO Alert Stage is reached. A BMO Alert Stage for electrical conductivity is reached if the measurements (EC uS) are less than 900 for drinking water or less than 700 for agricultural water. None of the samples taken in 2011 triggered a BMO Alert Stage.

[2] Fulton, Allen. “Seeking an Understanding of he Groundwater Aquifer systems in the Northern Sacramento Valley: An Update”. Article No. 1 – September 2005

To date, temperature has been basically consistent in all wells. Temperature is a standard parameter when assessing water quality because it affects chemical reactions that may occur in groundwater. Also, considerable changes in temperature could be an indication of other source waters migrating into the aquifer system such as stream seepage or flow from a different aquifer system. The lowest temperature reading was in the Durham/Dayton SIU (18 ^{o}C) and the high in the Pentz SIU (23.9 ^{o}C). Taking into consideration the small variances in temperature over the years, the temperature measurements are consistent with previous years' measurements.

Measurements for pH remained stable and within the secondary water quality thresholds. The highest pH was found in the Llano Seco well (8.05), which is consistent with previous years and was actually down from 2010. However, all measurements for pH were well within the secondary water quality thresholds.

Electrical conductivity (EC) measures the ability of a solution to conduct an electrical current. Readings for electrical conductivity varied more than pH and temperature, which has been consistent over the course of the sampling. However, all readings observed were well within the secondary water quality thresholds established by State and federal regulatory agencies. Degraded water quality is a predominant impact of over utilizing groundwater resources resulting in saline intrusion from, among other sources, marine formations underlying freshwater aquifers.

Overall, the results of the water quality sampling indicate that groundwater in the basin is of high-quality, is free of saline intrusion and is in good health. Water quality parameters have naturally occurring variability, so year to year changes are expected and not a cause for investigation or analysis. Further investigation would only be necessary if values were to fall outside of acceptable ranges.

Land Subsidence

Land subsidence is a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials caused by groundwater or oil extraction. The potential effect of land subsidence include differential changes in elevation and gradient of stream channels, drains, and water transport structures, failure of water well casings due to compressive stresses generated by compaction of aquifer systems and compressional strain in engineering structures and houses.

Land subsidence in the Sacramento River, San Joaquin River, and Tulare Lake Basins is most likely to occur as a result of aquitard consolidation. An aquitard is a saturated geologic unit that is incapable of transmitting significant quantities of water. As the pressure created by the height of water (ie., head) declines in response to groundwater withdrawals, aquitards between production zones are exposed to increased vertical loads. These loads can cause aquitards to consolidate leading to land subsidence. Factors that influence the rate and magnitude of consolidation in aquitards include mineral composition, the amount of prior consolidation, cementation, the degree of aquifer confinement, and aquitard thickness. Subsidence has elastic and inelastic deformation components. As the head lowers in the aquifer, the load that was supported by the hydrostatic pressure is transferred to the granular skeletal framework of the

formation. As long as the increased load on the formation does not exceed the pre-consolidation pressure, the formation will remain elastic. Under elastic condition, the formation will rebound to its original volume as hydrostatic pressure is restored. However, when the head of the formation is lowered to a point where the load exceeds pre-consolidation pressure, inelastic deformation may occur. Under inelastic consolidation, the formation will undergo a permanent volumetric reduction as water is expelled from aquitards.

Monitoring for the presence of subsidence occurs in Butte County and the region. The locations of the five extensometers that measure land subsidence within the County are shown on the 2011 monitoring network map in Appendix A. These extensometers were installed from 1999 and 2003, and continuously monitor for subsidence. Records from these extensometers are available by contacting DWR Northern Region or on the Northern Region web page (http://www.water.ca.gov/groundwater/data_and_monitoring/land_subsidence_data.cfm)

Over the past decade, GPS surveying techniques have proven to be so efficient and accurate that they are now routinely used in place of classical line-of-sight surveying methods. The monitoring of land surface elevations allows for measurement of any potential land subsidence.

The DWR is engaged in an ongoing program with northern Sacramento Valley counties to improve data collection and understanding of the aquifer system. In the mid/late 2000's DWR and participating local, state, and federal agencies established a Global Positioning System (GPS) geodetic control network in the Sacramento Valley. The Sacramento Valley GPS network incorporates existing GPS networks and monuments to create a regional network that covers part or all of Colusa, Sutter, Glenn, Butte, Yolo, Yuba, Tehama, and Placer Counties. Butte County participated in the Sacramento Valley Height Modernization Project during March 2008 as a means to enhance the subsidence monitoring program in the county and the region. This cooperative project between DWR, the United States Bureau of Reclamation (USBR) and local County agencies helped to establish baseline ground elevations in Butte County and other portions of the valley. Land elevations were measured using (GPS) survey equipment and survey monuments located on an approximate three to five mile grid. Re-observations are done approximately every three years proving a comparison to the baseline data in order to determine whether or not any subsidence has occurred.

According to the BMO Ordinance, an Alert Stage is reached if the annual elastic subsidence exceeds the average annual elastic subsidence measured over the period of record of the extensometer. Chapter 33 is intended to prevent or limit inelastic subsidence. To date, no inelastic land subsidence has been recorded in Butte County wells.

Groundwater Level Monitoring

Groundwater levels typically fluctuate seasonally and from year to year. These fluctuations of groundwater levels occur in response to recharge and extraction or natural discharge. Precipitation, applied irrigation water, local creeks and rivers, and

Thermalito Afterbay all recharge groundwater in Butte County. Consequently, groundwater levels are usually highest in the spring and lowest during the irrigation season in the summer months.

Long-term fluctuations occur when there is an imbalance between the volume of water recharged into the aquifer and the volume of water removed from the aquifer, either by extraction or natural discharge to surface water bodies. If, over a period of years, the amount of water recharged to the aquifer exceeds the amount of water removed from the aquifer, then groundwater levels will increase. Conversely, if, over time, the amount of water removed from the aquifer exceeds the amount of water recharged then groundwater levels will decline. These long-term changes can be linked to various factors including increased or decreased groundwater extraction or variations in recharge associated with wet or dry climatic cycles.

Currently 111 wells are monitored for groundwater levels in Butte County. These wells consist of a mixture of domestic and irrigation wells, along with dedicated observation wells. Approximately 43 of the 111 wells are equipped with data loggers which continuously monitor and record changes in groundwater levels. The remaining wells are measured by hand four times per-year, during March, July, August and October. The approximate locations of groundwater level wells monitored in Butte County are shown in Appendix A. The groundwater level monitoring methods are consistent with the procedures described in the DWR's Groundwater Elevation Monitoring Guidelines (December 2010). http://www.water.ca.gov/groundwater/casgem/documents.cfm Groundwater elevations are taken by either the steel tape method or by transducers. The accuracy of the groundwater level measurement is approximately 0.1 feet. In addition to the groundwater level monitoring conducted by Butte County and the DWR, California Water Service Company currently measures monthly groundwater levels in approximately 60 municipal groundwater supply wells in the Chico Urban and Oroville areas.

Data from groundwater level monitoring can be found on DWR and the Department websites. The DWR Northern Region maintains an electronic database of groundwater level measurements for Northern California (http://wdl.water.ca.gov/.). The database contains over 100,000 individual groundwater level measurements, some dating back to the early 1930's. Butte County also hosts an online groundwater management tool known as the BMOIC, or Basin Management Objective Information Center (http://gis.buttecounty.net/bmoic3/GIS/Default.asp?loadfile=map.asp&county=.). Data generated on either of these websites can be printed in varying formats.

Details on groundwater conditions are found in the following BMO reports prepared for 16 SIUs in Butte County. The 16 SIUs are located in one of four sub-basins (North Yuba, East Butte, West Butte and Vina). The BMO reports include information on monitoring activities, current conditions, BMOs, hydrographs and recommendations from stakeholders. Additionally, the BMO reports include hydrographs on wells that do not have a corresponding BMO. These wells were either key monitoring wells that were

monitored prior to the BMO program or are wells recently added to the monitoring network. The wells added most recently are typically dedicated monitoring wells.

BMOs were established for most of the wells in the monitoring network. BMOs are determined from historic data collected for the specific well. When a measurement fails to achieve the BMO for the well, a BMO Alert Stage is reached. When a BMO Alert Stage is reached, the Department increases outreach to stakeholders, seeks an evaluation by the Technical Advisory Committee and may conduct additional monitoring. Under the BMO program, stakeholders from the SIU unit participate in the evaluation and outreach of BMO data. The BMOs provide a standardized way to evaluate spring and fall changes in groundwater levels. Two methods are used to determine BMOs.

The first method is called the standardized method. The standardized method has two procedures depending upon the period of record for the well. The first procedure is for wells that have a period of record dating back to at least 1970. Measurements up through 2006 are used to set the BMO. The BMO is set by taking the historic low reading and adding 20% of the range of measurements from the first year through 2006. Measurements below the BMO and above the historic low would indicate an Alert Stage 1. Measurements at or below the historic low would indicated an Alert Stage 2. The measurements plotted after 2006 are for reference purposes only, and are not included in the calculation of the range.

The second procedure is for wells that have a period of record beginning later than 1970. For those wells, the historic low measurement prior to 2006 will indicate an Alert Stages 1. The historical low measurement minus the range of measurements would indicate an Alert Stage 2. The measurements plotted after 2006 are for reference purposes only, and are not included in the calculation of the range. All of the SIU utilize the standardized method, except for Richvale and Western Canal that use the specific depth method.

The BMO Ordinance allows for a second method called the “specific depth method”. For the specific depth method, the BMO is set based on the five feet below the average spring groundwater level recorded for the well. An Alert Stage 1 is reached if the spring measurement falls five feet below the average recorded groundwater level. An Alert Stage 2 is reached if spring groundwater levels, for a second consecutive year, remain five feet below the average groundwater level established for the well. An Alert Stage 3 is reached if the spring groundwater levels fall ten feet below the average spring groundwater level established for the well. Wells that utilize the specific depth method only have spring BMOs.

The 2012 BMO reports for each of the 16 SIUs can be viewed on the Department’s website under BMOs at:
http://www.buttecounty.net/Water%20and%20Resource%20Conservation/BMO.aspx